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JANUARY 19, 1987

CHEMICAL & ENGINEERING

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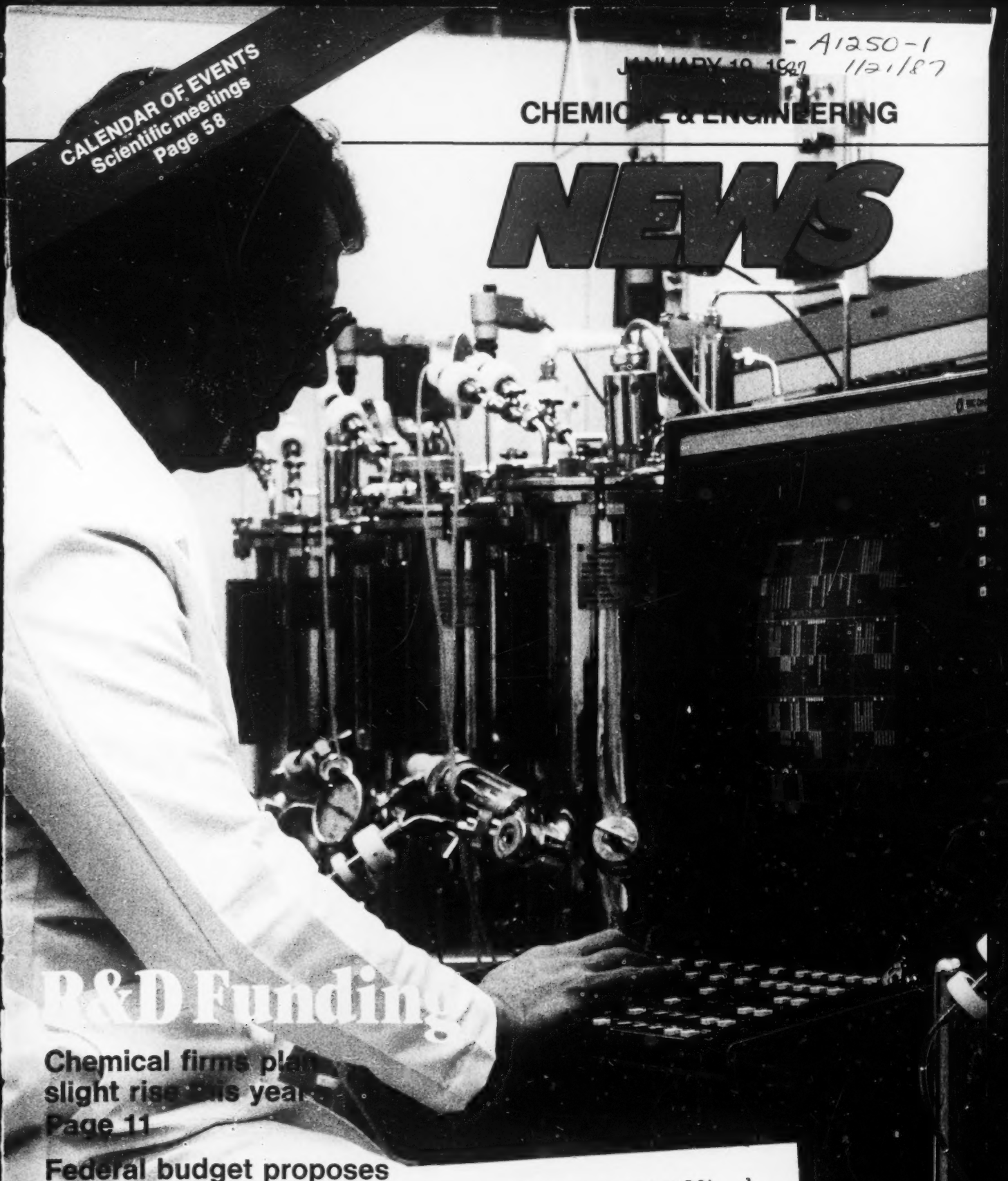

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Cover: Biotechnologist monitors distributed digital control system for advanced fermentation processes at Smith Kline & French Laboratories' R&D facility in Upper Merion, Pa.

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International Business

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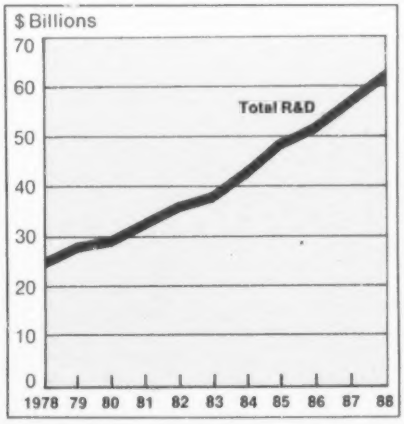


Government

Administration requests 8% increase in federal R&D budget for 1988, with a whopping 70% of the budget tagged for the Department of Defense. **Page 21**

Heavy oil/water emulsion seeks fuel oil market

A new emulsion technology that allows heavy crude oil and refinery by-products to be mixed with water into a low-viscosity, burnable fuel has been developed and patented by Petroferm, a small chemical specialties company located in Fernandia Beach, Fla. It has licensed the technology to Steuart Petroleum, a leading independent marketer of petroleum products in the eastern U.S.

The emulsified product, known as preatomized fuel (PAF), is a particularly stable emulsion of heavy hydrocarbons and about 30% water, explains Petroferm's president William R. Galloway Jr. It has a low viscosity that is not dependent on temperature. The company expects it to compete favorably with No. 6 fuel oil for large industrial and utility applications. Unlike No. 6 fuel oil, PAF can be stored and transported at ambient temperatures. It also burns more efficiently, Galloway says, "yielding a substantial reduction in particulate emissions compared to No. 6 oil." Its water content lowers its combustion temperature, and that decreases the nitrogen oxides produced during combustion. Sulfur emissions from the emulsified fuel depend on the sulfur content of the original petroleum starting material. PAFs made from starting materials with different sulfur contents can be blended to produce a fuel mixture that can be tailored to meet local sulfur emissions standards, Galloway says.

Petroferm's technology base comes from exploiting natural bacterial systems that produce oil-emulsifying biopolymers and surfactants. The proprietary chemicals it uses to make PAF include biopolymers, biostabilizers, and classical surfactants, the company says. □

Chemical stocks rise with market

As the Dow Jones Industrial Average broke through the 2000 barrier earlier this month and continued rising to record levels almost every day, chemical stocks more than went along for the ride. Since the beginning of the year, they have outpaced the Dow Jones average slightly.

Between Jan. 2, the first trading day of the new year, and Jan. 14, chemical stocks as measured by C&EN's chemical stock index rose 7.2%. The Dow Jones Industrial Average rose just 5.6% to close at 2035.

The C&EN index also outperformed most of the other standard measures of stock market activity. While the C&EN index rose 7.2%, the New York Stock Exchange Composite index increased 6.8% to close at 151; the Standard & Poor's 500 index climbed 6.6% to close at 263; and the Standard & Poor's 400 Industrials rose 7.0% to close at 294.

Only the indexes of smaller stock activity outperformed the C&EN measure. The American Stock Exchange Index, between Jan. 2 and Jan. 14, rose 8.3% to close at 290. But the best performance was seen in the over-the-counter stocks. The Over-the-Counter Composite rose 10.4% to 390; the Over-the-Counter Industrials rose 12.2% to 397.

Chemical stocks have outperformed most other indexes

	Jan. 14, 1987	Jan. 2, 1987	% change
C&EN Chemical Stock Index	464	433	7.2%
Dow Jones Industrial Average	2035.01	1927.31	5.6
New York Stock Exchange Composite	150.58	141.01	6.8
American Stock Exchange Index	289.68	267.49	8.3
Over-the-Counter Composite	389.95	353.26	10.4
Over-the-Counter Industrials	396.80	353.53	12.2
Standard & Poor's 500	262.64	246.45	6.6
Standard & Poor's 400 Industrials	293.78	274.58	7.0

Note: C&EN index based on the weighted stock price of American Cyanamid, Celanese, Dow Chemical, W. R. Grace, Hercules, Monsanto, and Union Carbide.

The C&EN chemical stock index is made up of the weighted stock prices of seven major chemical companies—American Cyanamid, Celanese, Dow Chemical, W. R. Grace, Hercules, Monsanto, and Union Carbide.

Of the companies that make up the index, Carbide has been the best performer since the first of the year, rising 13% to close at $25.75 per share on Jan. 14. It was followed by Dow Chemical, rising 8.8% to close at $65.25 per share, and Monsanto, up 7.6% to close at $82.75 per share.

The remaining four companies all showed below average increases. Grace increased 6.1%; Hercules rose 5.9%; Cyanamid increased 4.9%; and Celanese rose just 0.2%. □

Carbide wins round in Bhopal court battle

Union Carbide Corp. has won a key point in its legal battle with the Indian government over who is to blame for the chemical disaster in Bhopal. The Second U.S. Court of Appeals in New York ruled last week that Carbide should be given rights of gathering evidence in India equal to those the Indian government enjoys in the U.S.

The ruling was the second of two decisions made by the court. The first was to keep the trial in India, not move it back to the U.S. That decision ends any involvement by American lawyers on behalf of the victims.

In its appeal, Carbide was concerned that Indian procedures of discovery would prevent the company from gathering all the evidence it needs in showing that public and corporate elements in India were responsible for the disaster. India argued that Indian law was sufficient to guarantee Carbide all the rights of discovery it needed.

Carbide was appealing part of the decision made last May by the District Court in New York. The decision, which basically went in Carbide's favor, was that the trial be held in India, since most of the evidence resided there. Because the Indian government was basing its case on faulty engineering design by Car-

Chemical Industry R&D Spending To Rise Moderately in 1987

Major chemical producers project a 4% hike in research expenditures this year, following a 7% increase in 1986

William J. Storck, C&EN New York

The growth of the U.S. chemical industry's research and development spending in 1987 will slow considerably from 1986, according to C&EN's annual survey of 12 large chemical producers. The survey shows that R&D spending for 10 of the companies that were able to estimate their spending by press time will increase only 4% this year after an estimated increase of 7% in 1986. (Union Carbide and PPG Industries could not yet estimate 1986 spending nor could they forecast 1987 expenditures.)

The 4% increase for chemical firms in C&EN's survey is much lower than the 7% increase in R&D spending for all industry forecast by Battelle Columbus Laboratories (C&EN, Jan. 5, page 6).

The chemical industry's modest 4% increase also means that, adjusted for inflation, chemical R&D spending will have been essentially flat since 1985. The constant-dollar increase is figured using Battelle's estimates for R&D inflation for 1987 of about 3%.

The essentially flat nature of constant-dollar R&D spending is not surprising as corporate reductions in employment roles have been focussed on salaried workers and have cut into research roles along with other white collar programs. The paradox, of course, is that firms continue to say they are increasing their emphasis on higher-value-added products—items that, by their very nature, require greater R&D effort in terms of development as well as technical support for customers.

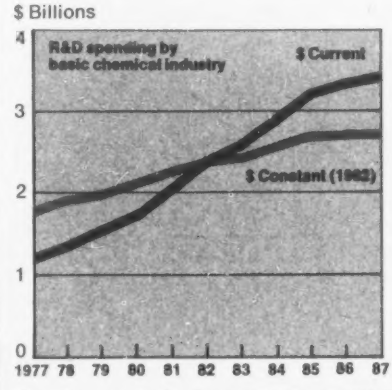
However, in many cases, this increased dependence on higher-value-added products is often taking place because companies are divesting themselves of their commodity businesses or acquiring companies making specialty products, rather than building the new businesses internally. A good example of this has been Monsanto, which has sold off its styrene and other commodity operations, while purchasing G. D. Searle, thus swinging its emphasis much more quickly than it could have done if it had decided to achieve the switch entirely through in-house R&D.

Thus, while the newly acquired operations may take more research dollars than the disposed-of commodity businesses, the increase for the total corporation is not so large as it would have been if the commodity businesses had been retained. This is because some R&D effort went along with them as they were divested. Further, in some cases, the commodity businesses go when the company decides to build on its existing specialty operations. In these cases, R&D spending actually can go down. During these times of flux in the chemical industry it becomes worthwhile to look at R&D spending as a percentage of sales to determine if a company is maintaining its funding levels, rather than looking only at the raw R&D spending totals.

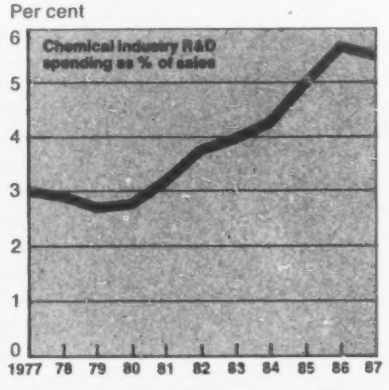
For the companies surveyed, C&EN estimates that R&D spending will amount to about 5.6% of sales in 1986, up from 5.0% in 1985. Although some of that is due to a relatively lackluster sales increase last year, it does indicate that companies are spending a bigger portion of their budgets on R&D.

Chemical companies also are directing a bigger percentage of future-oriented spending (capital expenditures plus R&D expenditures) toward research. In 1986, R&D for the 10 companies responding to the survey averaged almost 46% of total future-oriented spending for the

Growth of R&D spending will slow in 1987 . . .



. . . and will fall as per cent of company sales



Note: For companies listed on page 12. **Sources:** C&EN surveys and estimates, Battelle Columbus Laboratories

American Cyanamid, W. R. Grace will post biggest gains in R&D spending

$ Millions	Planned 1987	Actual 1986	Planned 1986	1985	1984	1983	1982	1981	Change from previous year 1987	Change from previous year 1986	R&D spending as % of sales 1986	R&D spending as % of sales 1985
Air Products[a]	$ 59	$ 61	$ 60	$ 51	$ 44	$ 40	$ 37	$ 32	−3.3%	19.6%	3.1%	2.8%
American Cyanamid	315	280	265	251	232	208	185	166	12.5	11.6	7.3	7.1
Dow Chemical	650	600	600	547	507	492	460	404	8.3	9.7	5.3	4.7
Du Pont[b]	1110	1070	1030	1080	1000	875	775	647	3.7	3.9	6.8	7.2
Ethyl	47	47	47	47	40	39	39	37	0.0	0.0	2.9	3.0
W. R. Grace	110	98	100	92	81	73	64	57	12.2	6.5	1.8	1.8
Hercules	67	73	69	76	72	74	74	65	−8.5	−4.1	2.8	2.9
Monsanto	575	575	520	470	370	290	264	233	0.0	22.3	8.1	7.0
Olin	60	57	59	53	52	49	45	38	5.3	7.5	3.3	3.0
PPG Industries	na	na	176	176	150	127	127	119	na	na	na	4.0
Rohm & Haas	133	130	125	124	109	100	92	77	1.9	4.8	6.1	6.0
Union Carbide	na	na	191	275	265	245	240	207	na	na	na	3.1
TOTAL	$3125	$2931	$3242	$3242	$2922	$2612	$2402	$2082			5.6%	5.0%
ANNUAL CHANGE[c]	4%	7%		11%	12%	9%	15%	16%				

a For fiscal year ended Sept. 30 b All figures exclude Conoco c For those companies reporting na = not available

group, more than double the 21% posted as recently as 1980. This is partly due to falling capital expenditures because of stagnant to decreasing demand for chemical products, but rising R&D budgets also definitely play a part. For the 10 companies surveyed, capital expenditures fell almost 40% between 1980 and 1986, but at the same time R&D spending was increasing more than 90% for an average of more than 11% per year.

For the 10 companies estimating their R&D expenditures, Du Pont is by far the largest at about $1.07 billion for 1986 or almost 36% of the total. To make the comparisons consistent, Du Pont's Conoco operations are excluded. The 1986 figure for Du Pont is up about 3.9% from 1985 levels. In 1987, Du Pont forecasts R&D spending of $1.11 billion, up about 3.7% from 1986.

The biggest increase in 1986 was at Monsanto, where spending rose an estimated 22% to about $575 million as the company added expanded research programs at its Searle subsidiary. At the beginning of last year it had forecast a solid 11% rise, but the final figure beat that by far. For 1987, however, Monsanto says its R&D spending will remain essentially the same as last year.

Air Products also showed a large increase last year, with R&D spending rising 20% to $61 million. However for 1987, the R&D budget at Air Products has been trimmed 3.3% to $59 million as a result of the elimination of some minor non-strategic areas and cost control steps that the company has taken. However, a spokesman says funding of major programs continues at levels equal to those in 1986.

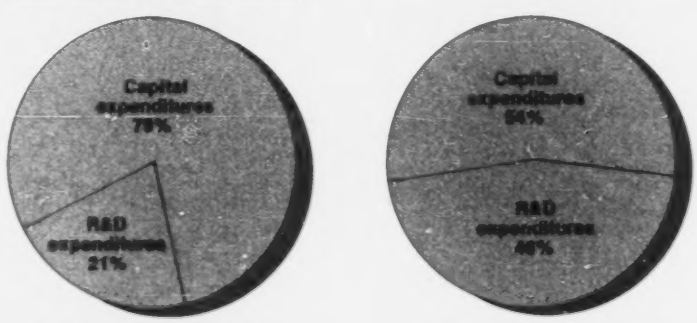
American Cyanamid spent 12% more on R&D in 1986—$280 million—than it did in 1985. Like Monsanto, it exceeded its earlier estimate, spending about $15 million more than it had intended at the beginning of last year. For 1987, Cyanamid expects to spend about $315 million, up 13% from 1986 levels.

Dow Chemical's R&D spending also increased more than average in 1986, with a 9.7% rise from 1985 to $600 million. For 1987, the company forecasts an almost equal increase of 8.3% to about $650 million.

Olin also increased its budget slightly above average in 1986, with a rise of 7.5% to $57 million. It will increase spending again in 1987 at a rate of 5.3% to $60 million.

Besides Air Products, the only company to forecast a decrease in R&D spending for this year is Hercules. A company spokesman says that spending in 1987 will total about $67 million, down 8.5% from 1986. And last year's R&D spending was down 4.1% from 1985. He says, however, that the decline this year will largely come because R&D budgets for water soluble polymers have been switched to the company's joint venture with Henkel in that area. □

R&D spending as per cent of future-oriented expenditures has increased dramatically



Total 1980 = $8.45 billion Total 1986 = $7.42 billion

Note: For companies listed above. Source: C&EN surveys and estimates

Administration Proposes 8% Rise In Federal R&D Budget for 1988

Department of Defense R&D budget consumes 70% of total R&D funding; proposed funding for basic research is up only 4% to $9.7 billion

Janice R. Long, David J. Hanson, and Wil Lepkowski, C&EN Washington

"Dead on arrival" was the phrase most often used by political pundits to describe the fiscal 1988 budget proposal that President Reagan sent to Capitol Hill Jan. 5. That phrase has always had a certain validity. No Congress has ever rubber-stamped a President's entire budget proposal, but with the Democrats firmly in control of both branches of Congress this year, it may be truer than ever.

However, it must be noted that when it comes to research funding, President Reagan and Congress have not been that far apart during his six years in office. Both think that science and technology have an important role to play in enhancing national security and strengthening the U.S.'s competitive position in international markets. Thus, although Congress has trimmed some of the Administration's research funding requests, particularly those for the Department of Defense, for the most part the President's R&D budget proposals have served as baselines, which are rarely cut and often increased.

That being the case, 1988 looks like another good year for federal research programs, unless Congress resorts to last-minute, across-the-board cuts to meet the mandatory deficit-reduction target of $108 billion. The budget, as proposed by Reagan, does meet that target.

In an overall budget that is up only 1% from 1987 to $1.024 trillion, obligations for R&D are up 8%, or $4.7 billion, to $62.4 billion. However, obligations for basic research are up only 4%, or $400 million, to $9.7 billion. More than half of that amount goes to support basic research at universities, according to Presidential Science Adviser William R. Graham. He noted that from 1982 to 1988 the amount of federal funds allocated to basic research will have grown more than 50%, despite the relatively low rate of growth in fiscal 1988.

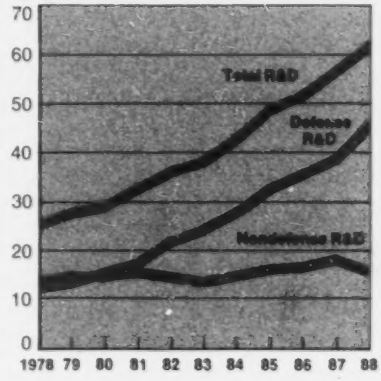
According to Graham, the fiscal 1987 R&D budget proposal exemplifies the Administration's recognition that the country's "future position in global markets will depend to a great extent upon the continuing development of the foundation of our science and technology in basic research; the allocation of our national resources on a long-term and reliable basis to generate new knowledge; and the effective and timely transfer of new knowledge from our laboratories and universities to our industry, economy, and national security." In addition, he says, the budget continues the emphasis of previous years on enhancing national security.

That emphasis just about jumps out of the R&D budget request. Once again the proposed increase in the Department of Defense budget for research, development, testing, and evaluation (RDT&E) is more than the total increase proposed for all federal R&D programs.

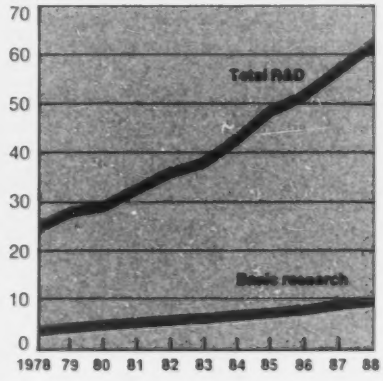
The Department of Defense budget is up 18%, or $6.8 billion, to $43.7 billion. Within that total, funding for the Air Force's RDT&E programs is up 21% to $18.6 billion, the Army's 16% to $5.5 billion, the Navy's 12% to $10.5 billion, and the defense agencies' 23% to $8.8 billion.

According to Defense Secretary Caspar W. Weinberger, "The President's highest priority defense effort is assessment of Strategic Defense Initiative technologies to support possible development decisions planned for the 1990s." The RDT&E

Defense R&D has risen as per cent of total R&D . . .



. . . while basic research's share has changed little



Sources: Office of Management & Budget, Office of Science & Technology Policy

budget request contains a total of $5.77 billion for SDI work. That's an increase of 61%, or $2.18 billion, over the fiscal 1987 funding level.

In addition, Weinberger says the RDT&E budget "reflects a balanced support of basic research and exploratory development in areas of emerging, high-potential technologies." However, according to DOD's own figures, funding for what most would consider basic research at DOD is up only 3%, or $26.3 million, to $918 million in fiscal 1978. Funding for development work is up 20%, or $6.8 billion, to $40.1 billion.

The requested 11%, $273.8 million, increase to $2.7 billion for the Department of Energy's defense R&D programs is enough to put its overall R&D budget request in the black. DOE's total R&D budget is up 2%, or $133 million, to $5.7 billion. However, the energy R&D budget is down 5%, or $140 million, to $2.9 billion.

Despite the overall lower request for energy R&D, some programs are slated for increases. Funding for the clean coal technology program, for instance, would get a 33% rise to just under $200 million. In fiscal 1988, the program will focus on technologies that could retrofit, repower, or modernize existing coal-burning facilities.

Also on the upswing is the environmental research program, which is up 12%, or $30 million, to $288 million. The budget increase will go, in part, to support expanded research programs on the sources and health effects of radon exposure and on detecting changes in human DNA caused by exposure to toxic pollutants. Finally, the budget for the general science programs is up 13%, or $95 million, to $815 million. The budget provides substantial increases for R&D on accelerators and experimental facilities, such as the continuous electron beam accelerator.

However, the budget request for supporting research and technical analysis is down 7%, or $42 million, to $597 million. That total is reduced because DOE is not seeking continued funding for a number of university construction projects that Congress added to its fiscal 1987 budget. In fact, DOE is asking Congress to rescind, or take back, the $69 million provided for the projects this year. If the projects aren't funded, the budget request reportedly would allow for a 5 to 6% increase in funding for basic energy sciences, which funds both the chemical sciences and materials sciences research programs.

Facing real budget decreases at DOE are conservation R&D, down 50% to $80 million; electric energy systems and storage, also down 50% to $14 million; fossil R&D, down 44% to $169 million; and solar R&D, down 36% to $94 million. The Administration has requested these kinds of cuts in these programs in every budget request it has sent to Congress, but Congress has never gone along with them and probably won't in fiscal 1988 either.

The fiscal 1988 budget request for the National Institutes of Health seems to be made up largely of "smoke and mirrors." Documents from the Office of Management & Budget show NIH's budget up a munificent 26%, or $1.7 billion, to $8.1 billion in fiscal 1988. Documents from NIH's parent organization, the Department of Health & Human Services, show NIH's budget falling from $6.2 billion in fiscal 1987 to $5.5 billion in fiscal 1988, a 10% decrease.

The HHS budget documents do not provide a line item breakdown of the budget by each institute; those details won't become available until late this month, when the budget is normally sent to Capitol Hill, so it's hard to tell what these conflicting figures really mean. However, the discrepancies seem to center on the number of new and competing research project grants NIH will be funding, a matter of ongoing dispute between the Administration, which has tried to decrease the number, and Congress, which keeps increasing it, to 6400 in fiscal 1987 to be exact.

According to HHS, the 1988 request for NIH is $5.87 billion in obligational authority. But this amount includes $334 million carried over from its fiscal 1987 appropriations, which have already been approved by Congress. The Administration is in effect requesting a $334 million decline in NIH's fiscal 1987 spending. But HHS says that its fiscal 1988 request includes $2.7 billion in order to meet future year commitments generated by new and competing grants awarded in 1988. In other words, it wants to provide full multiyear funding of those grants up front. The bottom line appears to show that both the 1987 and 1988 budgets are going to be lower than Congress probably wants.

According to HHS, the 1987 appropriations provided a 17% increase in research funding over 1986. "Such a large increase, especially in research project grants, cannot be sustained without significant displacement of other activities." Thus, it says, the proposed 1987 carryover of $334 million will reduce the number of projects by 700, resulting in only 5700 new and competing projects. The result of all this, however, might be a loss in the number of new grants that might be made for years after 1988. In the effort to budget multiyear support for NIH grants, the impact of lowering the number of grants may be hidden from all but the most searching eyes.

One item receiving special attention in the fiscal 1988 budget request is research on AIDS, acquired immune deficiency syndrome. Nearly $345 million has been targeted for work in that area, in several institutes, including vaccine development and clinical studies of promising drugs. However, the Administration also is proposing to cut back support of other research areas. It proposes not to fund any more biomedical support formula grants, funded at about $60 million for fiscal 1987, and it wants to drop $10 million in extramural construction projects. New construction also would be slowed at NIH, with a proposed construction budget of just $5 million for fiscal 1988, down from $32 million this year.

For the Food & Drug Administration, the President has proposed a $35 million budget increase, quite large considering the tight budgets usually set for regulatory agencies. But most of the increase is to come from $34 million in new fees FDA is supposed to charge companies for doing product reviews. This action

will require legislation and approval of Congress, and the Administration says such legislation is being prepared.

A third HHS agency developing a significant research budget is the Alcohol, Drug Abuse & Mental Health Administration. The Administration has proposed $361 million to support about 1600 research projects in fiscal 1988. This is a slight drop from the $376 million appropriated by Congress for this year. Much of the budget will go to research centers to support basic research in neurosciences, epidemiology, and molecular biology.

The National Aeronautics & Space Administration will never be the same as it was before the Challenger accident. Despite plans to move ahead with space shuttle flights in early 1988, events are moving past the agency at a rapid pace. The Defense Department is developing its own rockets to launch military equipment, and the Administration has begun an initiative encouraging private companies to fund their own rockets for business satellites. Still, the proposed fiscal 1988 budget for NASA shows a significant increase for R&D. On the other hand, NASA programs for space flight are down, primarily because, unlike the fiscal 1987 budget, the new budget includes no funds to build a new space shuttle.

Space station development continues to be a priority at NASA, getting a greater than 80% increase in support to $767 million. Civilian space efforts will be aided by a $70 million initiative to expand the technology base in such areas as earth-to-orbit propulsion systems, multispectral sensor devices, and high-capacity power systems. Although some programs, such as the Hubble Space Telescope, will be delayed, others are going ahead. NASA says the gamma ray observatory, the Magellan mission to Venus, the Galileo mission to Jupiter, and the Mars Observer will move ahead next year. There is also $25 million for a long-range project involving a series of spacecraft to study the basic physics of Earth's magnetosphere and solar-terrestrial relationships.

Much of NASA's research efforts will focus on work the agency has always done, such as wind tunnel testing, computational modeling, and experimental flight tests. Some basic research also will be done on fluid and thermal dynamics, propulsion, materials, and information sciences.

With a budget request of about $1.9 billion—an almost 17% increase over last year—the National Science Foundation finds itself riding higher than it ever has in its 46-year history. Specific breakdowns won't be forthcoming until Jan. 28, when the Office of Management & Budget releases the detailed budget. But from the Jan. 5 briefing delivered by a "happy" NSF director Erich Bloch, the foundation has won from the Administration the kind of plum it had been seeking for years: commitment by the Administration for significant budget increases over the next five years.

What Congress decides to do with NSF's plans is, of course, another question. But the big news in the fiscal 1988 budget for NSF is that guarantee. Specifically, the Administration is aiming at a $3.2 billion budget for NSF by 1992, roughly a doubling of the current fiscal 1987 budget and a tripling of the figure for fiscal 1982. Few can contend today that the Administration hasn't been "sold" on science and technology as a policy principle. Indeed, the commitment to double represents one volley in the Administration's set of policies to meet the challenge of international technological competitiveness, according to OMB sources.

On the whole, though, NSF will be carrying out programs little changed basically from those developed over the past two years. There is one exception to that, however. Bloch announced one major new program—establishment of five to 10 new multidisciplinary science and technology centers to join with the existing engineering research centers announced three years ago. The new centers will focus on specific areas in biology and biotechnology, social and behavioral sciences, computer and information sciences, and materials science.

Just how these new centers will differ from the engineering research centers is one of the more interesting questions circulating around NSF. As one division director puts it: "How can you have a science and technology center without engineers, or an engineering research center without scientists?" The concept could give Bloch some organizational challenges. The engineering centers are administered by NSF's engineering directorate whereas the new centers will be funded by the separate research directorates. What could happen is that all center activities could be lumped together in a single NSF unit.

NSF may be riding high, but it is clear from the tone of Bloch's remarks during his briefing that in view of the challenges ahead, the country faces severe problems in its efforts to compete in a technological world. "Too few of our students are choosing science and engineering careers," he says. "Too few of those continue to the Ph.D. And our trade statistics have deteriorated. That is not the way to be competitive."

In any case, NSF is far different than it was five years ago. Science education is back in the saddle with a budget increase of 16%, or $16 million, to a total of $115 million. Computer and information science and engineering is a brand new directorate with a $143 million budget and an increase of 23%. Engineering is still enjoying its revival with a hefty boost—at 26% the biggest of all—to $205 million. Geosciences rises 16% to $330 million. The smallest increase goes to the biggest directorate, mathematics and physical sciences, 11% to a total of $514 million.

Within that directorate is NSF's division of chemistry. And while the breakdown is still pending, sources say that chemistry's growth simply follows the usual historical line—11% for fiscal 1988. Last year the Administration proposed an increase of 18% for chemistry at NSF in response to the Pimentel Report. But Congress scaled that back to 9%. This year NSF isn't so ambitious for chemistry.

Other highlights in the NSF budget include upgraded programs in undergraduate teaching and research, futher emphasis on encouraging minorities and women to en-

HOW THE AGENCIES FARE

DOD: development work big gainer

$ Millions	1988[a]	1987[a]	1986[b]	% change 1987–88
Advanced development	$14,602.4	$10,938.0	$9,472.1	33%
Engineering development	13,112.0	10,114.9	9,215.4	20
Operational systems development	9,872.8	9,876.6	9,066.8	0
Management and support	2,711.1	2,783.1	2,689.4	−2
Exploratory development	2,502.7	2,341.6	2,278.7	7
Research	918.0	891.7	953.7	3
TOTAL RDT&E	$43,719.0	$36,945.9	$33,676.1	18%

a Estimate. b Actual. Source: Department of Defense

Innovative bookkeeping actually reduces 1988 NIH funds

$ Millions	1988[a]	1987[a] Appropriated	1987[a] Revised	1986[b]	% change 1987–88
Research project grants	$3059	$3397	$3063	$2896	−10%
Other research activity	2466	2534	2534	2258	−3
AIDS	344	253	253	135	36
Total obligations	5869	6184	5850	5289	−5
less carryover	−334	—	334	−11	
TOTAL BUDGET AUTHORITY	$5535	$6184	$6184	$5278	−10%

a Estimate. b Actual. Source: Department of Health & Human Services.

DOE: energy R&D down, defense up

$ Millions	1988	1987	1986	% change 1987–88
Energy R&D	$2937.4	$3077.8	$2899.4	−5%
General science	814.5	719.2	661.4	13
Supporting research & technical analysis	596.7	639.1	487.7	−7
Magnetic fusion	345.6	345.3	365.5	0
Nuclear energy	336.4	329.3	375.7	2
Environment	288.0	258.0	228.6	12
Clean coal technology	199.1	149.1	99.4	33
Fossil energy	169.4	301.9	296.9	−44
Solar & other renewables	93.6	146.3	171.8	−36
Conservation R&D	80.1	161.7	183.6	−50
Electric energy systems & storage	14.0	27.9	28.8	−50
Defense R&D	2699.5	2425.7	2118.1	11
Weapons R&D, testing	2087.5	1850.3	1582.4	13
Naval reactors development	612.0	575.4	535.7	6
TOTAL	$5636.9	$5503.5	$5017.5	2%

Note: All numbers are estimates. Sources: Department of Energy, S. Repts. 99–397, 99–441

USDA: Total R&D budget is down

$ Millions	1988[a]	1987[a]	1986[b]	% change 1987–88
Agricultural Research Service	$542.6	$526.6	$489.3	3%
Cooperative State Research Service	240.3	307.9	285.5	−22
Forest Service Research	122.2	125.9	120.1	−3
National Agricultural Library	12.4	11.1	10.8	12
TOTAL	$917.6	$971.5	$905.7	−6%

a Estimate. b Actual. Source: Department of Agriculture

ter scientific careers, an expanded program of support for geographically out-of-the-way universities with relatively weak research programs, and new research programs in materials processes and interfaces, cognitive science, large systems engineering, supercomputer applications, low-temperature chemistry, and storm-scale meteorology.

At the Department of Commerce, the Administration is seeking a 2%, $25 million, cut to $1.1 billion in the National Oceanic & Atmospheric Administration's budget. This would entail cutting the budget of the national underseas research program in half to $5 million in fiscal 1988 and eliminating it entirely by 1989. The coastal zone management and sea grants programs would be phased out by 1990 for savings of some $80 million per year.

However, funding for the National Bureau of Standards is up 14%, or $17 million, to $139 million under the budget proposal. Funding for the Patent & Trademark Office is up some 38% to $136 million. Part of the budget increases at these two agencies will be funded through increased users' fees.

Research and development work at the Department of Agriculture is carried out by the Agricultural Research Service. For fiscal 1988, the Administration has proposed a $16 million, or 3%, increase to $543 million for ARS, mostly for increased research in the areas of plant and animal productivity. Some $7 million of the increase, however, goes to additional research in germplasm acquisition, maintenance, evaluation, and enhancement. There is also a related construction proposal to design and build a new national seed storage lab by 1989. This would replace an existing, outmoded storage lab currently at Ft. Collins, Colo. There is also $2.1 million for animal productivity research to reduce fat concentrations in livestock by focusing on biochemical and physiological factors to control fat deposition.

The Cooperative State Research Service, which administers funds at the state level for research at universities, gets a significant cut in its funding because of the proposed abolishment of the special research grants program, which was set up to focus attention on specific problems. The Administration has proposed cutting out the entire $49 million that program is receiving in fiscal 1987, maintaining that the states should use their own funds to solve these problems as they arise. CSRS competitive research grants get a slight increase to $44.5 million from $40.7 million, but that includes no additional funds to support research in biotechnology. There

NSF: research funds post big increase

$ Millions	1988	1987	1986	% change 1987–88
Research & related activities	**$1635**	**$1407**	**$1294**	**16%**
Mathematical & physical sciences	514	464	435	11
Geosciences	330	285	266	16
Biological, behavioral & social sciences	297	257	239	16
Engineering	205	163	144	26
Computer, information science & engineering	143	117	100	22
Program development & management	95	77	72	23
Scientific, technological & international affairs	51	44	38	16
U.S. Antarctic programs	**143**	**117**	**110**	**22**
Science & engineering education	**115**	**99**	**85**	**16**
TOTAL	**$1893**	**$1623**	**$1489**	**17%**

Note: All numbers are estimates. **Sources:** National Science Foundation, H. Rept. 99–619

EPA: Superfund gain boosts total R&D

$ Millions	1988[a]	1987[a]	1986[b]	% change 1987–88
Air	$ 65.5	$ 63.0	$ 66.4	4%
Superfund	59.8	39.5	10.6	51
Energy/acid rain	58.9	59.6	53.6	−1
Hazardous wastes	45.2	50.6	51.4	−11
Toxic substances	29.0	31.1	34.3	−7
Water	24.7	24.4	28.3	1
Drinking water	23.9	24.0	23.3	0
Interdisciplinary	22.9	27.9	28.6	−18
Pesticides	13.2	12.5	11.7	6
Management/support	9.8	9.7	9.6	1
Radiation	1.4	2.7	0.2	−48
TOTAL	**$354.3**	**$345.0**	**$318.0**	**3%**

a Estimate. b Actual. **Source:** Environmental Protection Agency

NASA: Space station, research big gainers

$ Millions	1988[a]	1987[a]	1986[b]	% change 1987–88
Conduct of R&D	**$3623.4**	**$3071.7**	**$2619.3**	**18%**
Space station	767.0	420.0	200.3	83
Space transportation	568.8	495.5	403.9	15
Physics and astronomy	567.1	522.3	569.3	9
Space applications	559.3	543.7	487.5	3
Aeronautical research	375.0	376.0	337.3	0
Planetary exploration	307.3	358.4	353.6	−14
Space research & technology	250.0	171.0	151.4	46
Life sciences	74.6	72.2	66.1	3
Transatmospheric research	66.0	45.0	—	47
Commercial applications	54.0	41.3	26.8	31
Tracking & data acquisition	18.1	17.1	15.5	6
Safety & reliability	16.2	9.2	7.6	76
R&D facilities	**195.5**	**166.3**	**137.5**	**18**
TOTAL	**$3818.9**	**$3238.0**	**$2756.8**	**18%**

a Estimate. b Actual. **Source:** National Aeronautics & Space Administration

is also a proposal to end construction of new facilities under CSRS. The Administration contends that because the five-year research facility construction program authorized by the 1981 farm bill expires in fiscal 1987, no new funds are needed.

In addition, USDA will be cosponsoring with DOE and NSF a new $10 million plant science initiative. It will focus on the application of modern techniques in cellular and molecular biology to plants and it will involve the establishment of multidisciplinary basic research and training centers at academic institutions with industrial and local and state government participation.

As a research program, the Environmental Protection Agency's is not large compared to others, but its R&D efforts have far-reaching effects. For fiscal 1988, the Administration has reduced most EPA research activities. Its overall R&D budget is up 3%, or $9 million, to $354 million only because of the expanded work required under the recently passed Superfund reauthorization.

This program, which is supposed to provide health and environmental risk assessments and evaluate demonstrations of commercially developed remedial cleanup technologies, among other things, is slated for a 51%, $20 million, increase to $60 million. Unfortunately, the agency's hazardous waste R&D is being cut more than $5 million. This reflects a reduction of interest in developing new alternatives to land disposal of these wastes.

New requirements in the 1986 Drinking Water Act also are covered in the R&D budget proposal. The emphasis here will be on providing additional control technology data on the effectiveness of pollutant removal technologies and developing better health effects data. Groundwater research also will be a priority next year.

Acid rain is another program the Administration is highlighting. It has proposed spending $55.3 million for research on it in fiscal 1988. This is almost the total amount EPA has budgeted for energy-related pollution. The Administration says this will support continued work on evaluation of atmospheric models for acid deposition and more work on aquatic effects and materials damage. EPA also is expected to provide data to the Energy Department for the Clean Coal Technologies program that DOE is doing with Canada. There is some concern, however, that the President has not given the support necessary to begin solving the acid rain problem, and that Congress, with prodding from Canada, may expand the clean coal program significantly. □